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ELECTROLYTIC GRINDING, CUTTING METHODS BEING APPLIED IN USSR AND RUMANIA

/Numbers in parentheses refer to list of sources appended./

Grinding

Spark grinding of hard-alloy cutting tools, which was first publicized in connection with turner Bortkevich's speed up of metal cutting in July and August 1948 (1), and later "introduced" at the Saratov Ship-Repair Plant (2) in May 1949, has since made its appearance in a number of Soviet plants. At the Tbilisi Machine-Moulding Plant spark grinders are used for sharpening tools for the T-4 lathe (3), while the Kirov Plant in Leningrad claims six shops equipped for spark grinding of tools (4). The Elektrosila Plant in Leningrad, manufacturer of the spark plating unit (5), itself uses spark finishing on cutting tools, as do a number of other Leningrad plants (4). The Kirov plant claims that electrolytic methods have doubled and tripled the durability of its tools (4). The technical council of the Elektrosila Plant recently discusses spark processing at one of its regular meetings. Doctor of Technical Sciences and Stalin Prize Winner B. P. Lazarenko took a leading part in the discussion. (6)

A new development in spark grinding is its application in bearing manufacture. In one shop of the First State Bearing Plant, spark grinding of bearings has eliminated the need for abrasive wheels. (7)

Spark grinding is also finding application in Rumania at the Bucharest "Dinamo" Plant. The grinding wheel is of cast iron, rather than imported Vidia steel which was formerly used for tool grinding. The old wheels were good for only 4-5 days. The designers and builders of the new device were Engineer Iosif Manceas, Nikolae Piederer, N. Hanganu, N. Marin, Gheorghe Chezar, Vasilie Patrulei, and Toma Neghel. Dust and chips are eliminated during grinding. A few days ago, the "Dinamo" Plant gave a special demonstration of the device before representatives from the Steagul Rosu Metallurgical Plant in Brasov. The visitors brought their own samples for grinding on the spark machine. Excellent results were obtained. (8)

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There is evidence, however, that spark grinding is not universally appreciated in Soviet plants. At the Riga Turbine Machinery Plant, the shortage of hard-alloy cutters and the plant's failure to institute centralized tool-grinding service has held up the conversion to high-speed cutting methods. Despite these difficulties, the plant has not even set up a spark-grinding unit which it owns. (9)

Cutting, Machining

The anode-mechanical or electrolytic method of cutting metals has shown good results on raw steel, and is the only method of cutting hard alloys and hardened steel.

In this method of cutting, the tempered steel maintains its hardness, while in cutting raw steel, surface hardening takes place only to a depth of a few hundredths of a millimeter, which does not interfere with subsequent machining of the piece.

The finish of the surface cut is so satisfactory that the faces of cushion dies, for example, do not require further machining.

Any type of metal can be cut by the anode-mechanical method, the efficiency depending on the degree of heat conduction, heat capacity, and melting point. The higher these parameters, the lower the efficiency.

Kh. M. Sarbash has designed a highly efficient electrolytic disk saw which can be set up on the basic units of a simple lathe or turret lathe. Either direct or alternating current may be used. For direct current, a 25-30 volt, 250-300 ampere generator is used for the current flow between the cutting disk and the work piece. For alternating current, an ST-2 welding machine transformer may be cut into the circuit. The electrolyte remains unchanged in either case. A 300-ampere mechanical or other rectifier should be used when working with alternating current.

Economically, the anode-mechanical method of cutting steel completely justifies itself. The greater wear of the cutting disks can be ignored in view of their negligible cost. The disk on the saw discussed above is 500-600 millimeters in diameter and 1.5-2 millimeters thick, made of sheet steel. In shop use, it will cut 50-millimeter sheet steel at a rate of 136 minutes per linear meter, whereas arc cutting takes 280 minutes, and cutting with a 6-millimeter bit 565 minutes per linear meter. (10)

The Riga Turbine Machinery Plant has an anode-mechanical saw suitable for cutting large steel billets. However, it has not yet been set up for use. (9)

Another development in the field of spark working of metals is the machining of dies. The "Krasnogvardeyets" Plant in Leningrad built the first electric spark unit for this purpose. (11)

Plating

The electric spark unit for plating the cutting edges of tools with hard alloy was developed by the Elektrosila Plant imeni S. M. Kirov in Leningrad (12) and is currently being produced by that plant (5). The unit is receiving a great deal of attention at enterprises in Leningrad and other cities. Numberous requests for plans and schematic drawings have been received, in response to which the Bureau of Technical Information has distributed over 300 plans to enterprises in Leningrad, Khar'kov, Sverdlovsk, Odessa, Baku, and Latvian SSR. Representatives from other enterprises come to the Elektrosila tool shop almost daily to study the unit in operation. (12)

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SOURCES

1. Zarya Vostoka, No 154, 3 Aug 48
2. Rechnoy Transport, No 39, 17 May 49
3. Zarya Vostoka, No 172, 1 Sep 49
4. Leningradskaya Pravda, No 222, 20 Sep 49
5. Pravda Ukrainy, No 235, 5 Oct 49
6. Leningradskaya Pravda, No 226, 24 Sep 49
7. Moskovskiy Bol'shevik, No 288, 27 Sep 49
8. Viata Sindicale, No 669, 18 Nov 49
9. Sovetskaya Latviya, No 237, 7 Oct 49
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12. Sovetskaya Estoniya, No 237, 7 Oct 49

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Electric Spark Cutting Method

LENINGRAD INDUSTRY BROADENS USE OF SPARK UNITS; MINISTRY BOASTS 4,000 HIGH-SPEED TURNERS

MAKE DIES ON SPARK MACHINE -- Leningradskaya Pravda, 18 Aug 50

The electric-spark machine tool can make dies better and faster than the most skilled worker. Every day the progressive electric-spark method, developed by B. R. Lazarenko, finds wider and wider application in Leningrad industries.

Production men go to the electric methods laboratory of the Leningrad House of Technology to learn new aspects of the field.

Railroad workers of the October Railroad System, who need a good method of sharpening the hard-alloy cutters used in high-speed facing of railroad car wheels, have shown particular interest. Cutters that used to require 10-12 hours' grinding now come out of the tank in less than an hour.

The technology of making blanking dies has recently been revised at the Leningrad Elektrosila Plant. Previously the dies could only be made by the most experienced craftsmen. Now such dies are made by only medium-skilled workers. Men of this trade are now known as "electrosparkers." The new method has vastly improved the quality of dies, speeded their manufacture, and will save the plant millions of rubles.

Electrical Metalworking

B.R. Lazarenko, with the aid of his brother, evolved a scheme for an electric circuit which causes the electrode to penetrate metal. They experimented with this electrospark method as a means of finishing metals. Both contact and non-contact circuits were used. The non-contact method proved easier and simpler.

V.T. Vasil'ev utilized their electric spark gap method to effect metallic erosion, intending that this process should be used in the machine tool industry to replace such steps as drilling, boring, threading, and grinding.

Basically the system operates by charging a condenser, then instantly discharging it with a spark that breaks up the metal particles. The cutting, or burning piece is the electrode, while the metal to be worked is the anode. This process of charge/discharge is repeated in rapid succession for the duration of the work to be done. In the Vasil'ev method, both the burning anode and the metal to be worked are immersed in a liquid medium.

A multi-electrode cutting method has been proposed to cut down the number of steps necessary in making more than one drill, cut, or tooling. Electronic control of the multi-electrode circuit is also proposed.

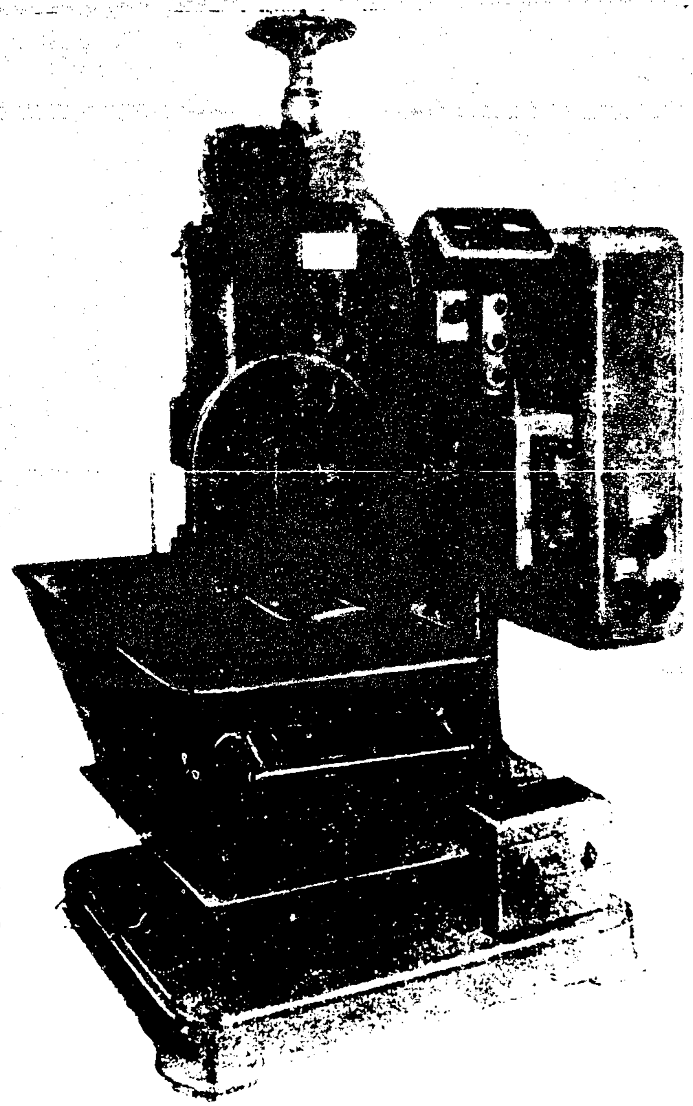
Vasil'ev himself points out the following disadvantages of this system, "low efficiency, high consumption of electrodes, and high consumption of electric power." The advantages which he claims for this method are, "complex constructional forms...made very simply. The hardness of the metal is unimportant."

A consensus of opinion of ~~US~~ engineers, manufacturers, researchers, condenser specialists, and welding specialists discredits the Russian claims. They point out that the theory is basic and simple, and certainly not new. They limit its practicality to a very few specialized uses on very hard metals and for some tooling of irregular shapes. Against this they list among its disadvantages the short life of the condensers due to heavy strain, the short life of electrodes (since electrodes lose an amount equal to the burned metal), high cost of power, maintenance problems, and the lack of precision in the finished product.

This method, claimed new and original by the Russians, contains nothing not already known here. Several U.S. firms produce apparatus using substantially the same theory for simple cutting. No sort of precision can be obtained, and further, this scheme for cutting is less efficient than conventional methods. Research men feel that it is not worth putting a research man on the project. In contrast to this, the Russians claim to be using this method for precision machine-tooling and grinding. ~~Possibly this method is new to the Russians, which would point out the backwardness of their industrial experiments~~.

The Russians claim this scheme is already being used successfully in industry. However, the descriptions given show that the method has not progressed beyond the stage of a raw idea. Expert opinion here runs contrary to the high claims for this method which are being greatly heralded in the Soviet press. As did the Germans in World War II, the Russians are attempting to make science all-practical, and are widely publicising this "new" machine-tool production method. It has already been proved here to be worthless in the fields which the Russians claim to be using it. ~~Although the claims for this method are great, their accounts of the process show it to be still in the small scale experimental stage, and~~ As is usual with Soviet published industrial developments, no data as to production or quality is given.

~~This is believe~~d typical of Russian claims of advancement in research and application. This particular subject has been selected from many such cases known to this Agency. It serves as a good basis for judging Russian sociological and scientific propaganda. Probably a further significant implication is that the Soviets are trying desperately for methods to reduce shortages in abrasives and machine-tools.



USSR

MODEL LV-16 ELECTRIC-SPARK SAW. 1950.

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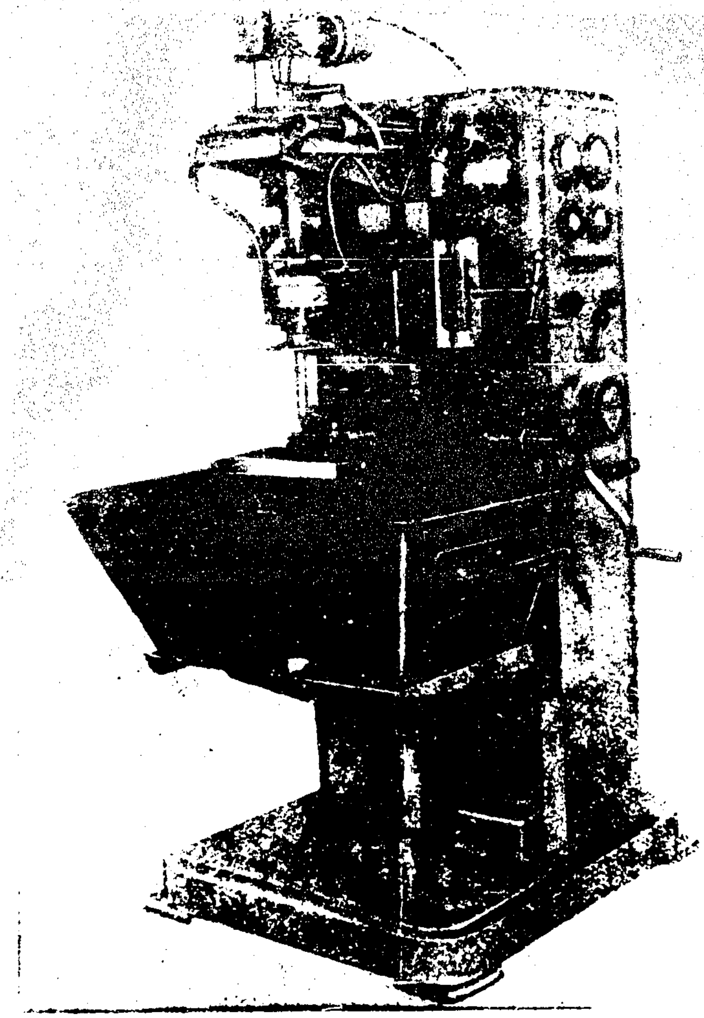

-18 6-KILOWATT HEAVY-DUTY DRILL. 1950.

CIA 43707

Subject: Electric Spark Metal Erosion

From : Industrial Bulletin of Arthur D. Little Inc.
Cambridge, Mass.; Number 280, October 1951

Putting Sparks to Work

The sparks which destroy automobile-distributor points and erode electrical switches and contacts have been put to work shaping metals which cannot be formed by machining. The new "Method X" is suitable for sintered carbides, hardened steels for tools and dies, alloys used in gas turbines, and special-use materials like titanium, molybdenum, and zirconium, or, as a matter of fact, any electrically conducting material. The process is being introduced to American technology by the Method X Corporation, an affiliate of the Firth Sterling Steel and Carbide Corporation.

In this new technique, the metal erosion caused by a condensed spark discharge is electronically controlled in intensity and duration. There is no physical contact between the "tool" and the work; the tool does not cut, as in conventional machining practice, nor does it melt off the metal, as in electricarc methods. The tool is brass and is one electrode of an electric circuit, with the work piece the other electrode. An electrical condenser is connected in the circuit across this gap. Rapid interruption of the electric circuit causes a spark to jump the gap between the electrodes, producing controlled erosion of the work piece, and forming it to the desired shape. This erosion can be controlled to make screw threads, round or shaped holes, all the way through the work or not, and to cut the work off or turn it down, as in a lathe. The process is particularly applicable to making holes only partly through the work and to forming curved holes or undercut recesses. It can also be used for shaping cams and dies, sharpening hardened tools, marking, and engraving. The process is now being used in the production of various types of dies, threading carbides for hold punches, and other special applications. It is claimed that size tolerances can be held to within 0.0005 inch, and location tolerances are limited only by the accuracy of the machine tools for positioning the tool and the work. The surface finish obtainable is comparable to that achieved with coarse grinding or diamond-tool turning.

The machine for spark discharge work consists of a base similar to a drill press with a rotable work bed, which can be raised or lowered on a rack. The work is mounted on this bed, completely submerged in a tank of non-conducting fluid, such as kerosene, fuel oil, or a specially developed fluid. A pumping system circulates the fluid, [redacted] over the work surface, removing chips and improving the stability of the spraking process. An exhaust system removes fumes from the breakdown of the fluid, which must be replenished to make up for decomposition and evaporation and for that which adheres to finished parts.

Subject: Electric Spark Metal Erosion

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Cambridge, Mass.; Number 280, October 1951

Automatic Control

The "cutting tool" is a negative of the shape to be produced, and is adjusted to maintain a space in the range from 0.0004 to 0.007 inch between it and the work. The tool is automatically fed by a servomechanism. If a chip lodges between the tool and the work, the tool backs off until the circulating fluid washes the chip away. The machine is set for a voltage between 50 and 300 volts to cause a spark to jump the gap between the electrodes. The tool is consumed in the process, thus using more metal than other machining methods, but since the products, such as carbide dies, are otherwise unmachinable, the expense is often justified. Since the tool does not touch the work, the rigid machines necessary with conventional methods are not used. Simple holding devices clamp work pieces and rigid floor mountings are not essential.

The mechanism of spark erosion is still obscure. Some experts believe that the high current densities in the spark discharge result in high mechanical stresses on the surface which cause particles to detach themselves without melting, leaving the exposed surface unchanged. In Russia, where the process is in widespread use, at least two hypotheses are advanced. One ascribes the effect to the impact action of the high energy discharge. The second claims that the short duration and extremely high current density of the spark discharge leads to high energy in the surface, causing explosive vaporization of the electrode metal. Jets or flares of vaporized metal from one electrode would thus erode the opposite electrode when they hit.

Sharpening Carbide Tools by the Electric Spark Method*

By W. N. ULITIN

The scarcity and high cost, in the USSR, of abrasives suitable for grinding cemented carbides have tended to restrict the use of these materials. Prof. V. A. Krivoukhova, director of one of the Russian technical institutes, has investigated methods of grinding and finish-grinding by the electric spark method, which does not entail the use of abrasives. Briefly, the process consists in presenting the workpiece to the surface of a rotating conductive disc or drum, and passing a D.C. current between them. The workpiece is connected to the positive lead, and the revolving disc to the negative.

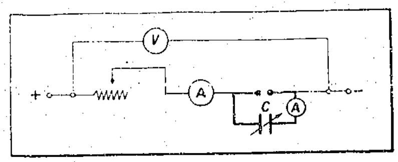

Fig. 1. Circuit for the Electric Spark Method

Apart from the design of the necessary electrical equipment, the investigations were intended to establish fundamental data for working cemented carbides efficiently, whereby a high surface-finish could be obtained without affecting the properties of the material. The equipment constructed permitted trials to be made under various operating conditions with disc surface speeds of 5, 10, and 15 metres per second (approximately 980, 1,970 and 2,950 ft. per minute). In the electrical system, the voltage could be varied from 20 to 220, the current from 0.1 to 150 amp., and the capacitance of the oscillator-circuit from 1 to 400 mfd.

Among the electrode-disc materials employed were cast-iron, steel, cupro-graphite, and aluminium, while the cutting-alloys were of grades designated T 15K (tungsten carbide 79, titanium carbide 15, and cobalt 6 per cent), and BK8 (tungsten carbide 92, and cobalt 8 per cent). The cooling media employed included various oil emulsions and air. In Fig. 1 is shown a diagram of the electrical circuit, based upon suggestions made by B.R. and N.I. Lazarenko,† while the general layout of the equipment is seen in Fig. 2. Throughout the investigations a suitably adapted grinding machine of conventional type was employed, the electrode-disc being mounted on an extension spindle. Referring to Fig. 2, current is supplied by a motor-generator set *B*, and the tool to be ground, seen at *C*, is connected, as already stated, to the positive lead. The negatively-connected electrode-disc, which is insulated, is shown at *D*, and is driven by an A.C. motor *E*. A pump *F* delivers coolant to the working zone between the tool and the electrode-disc.

The extension-spindle and insulated mounting of the electrode-disc are shown in greater detail

† See note at end of article.

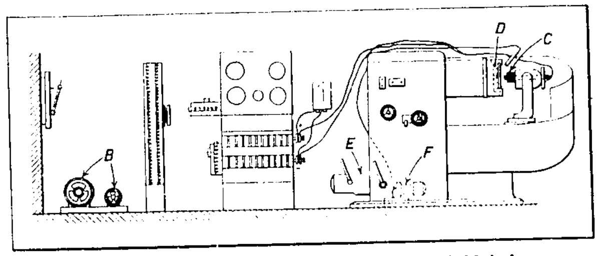

Fig. 2. General Layout of Equipment for Electric Spark Method

* Abstract of an article published in *Stanki i Instrument*, 1950, Vol. 21 (10), pp. 3-6. In a foreword by the editor of that journal, the importance of improved methods of sharpening carbide tools, in view of the trend towards higher cutting-speeds was pointed out.

There were, he stated, two techniques in use in Russia, which did not require abrasive wheels, namely, the "anodic-mechanical" and the "electric low-voltage spark" methods. The author, he pointed out, is an advocate of the electric spark method, with which this article is concerned.

teeth on the underside of the feed bar, thereby imparting to the latter twice the movement that would be provided by the cam and lever alone.

The set-up on a Brown & Sharpe No. 2 G machine, shown in Fig. 15, is for finish forming, threading, and drilling the end of a component (Fig. 16) for an electric Windtone horn. In this case a vertical magazine, as seen at A, is mounted on a special bracket, and is so designed that the blanks can only be loaded with the milled slots to the right and the shanks to the left. The parts make contact with each other on their outside diameters and there is no tendency to jam during feeding.

The feed bar B to the right of the magazine, which transfers the parts into the turret holder C, is coupled by the arm D to another axially moving bar E. This bar is actuated by the cam on the front shaft normally employed for the transfer arm of the screw slotting attachment. The speed for forming and drilling is 1,490 r.p.m. and for threading, with a Landmatic die head, 315 r.p.m., and the cycle time is 27½ sec.

A component is seen at F being pushed into the turret holder. The latter is axially spring-loaded so that the part can be pushed against a step in the collet. Like the armature shaft, the work is ejected against a rubber pad, seen at G in the turret.

It may be noted that the company make extensive use of statistical quality control throughout the automatic shop and particular importance is attached to the maintenance, by all concerned, of the routines specified for this technique by the inspection department. To facilitate the checking of samples the various gap, length, plug and thread gauges required for a particular component are mounted on a frame convenient to the operator.

A typical set of gauges arranged in this manner is illustrated in Fig. 17, and above them

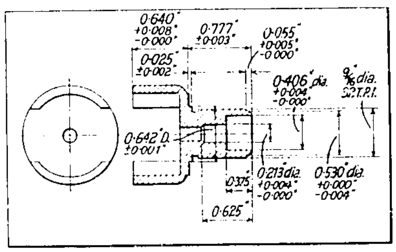

Fig. 16. Details of the Operation Performed on the Windtone Horn Component

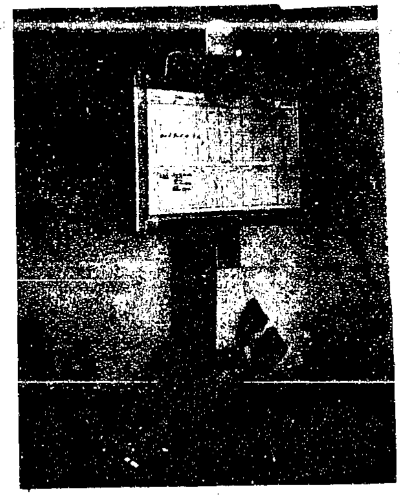

Fig. 17. Typical Arrangement of Gauges on a Stand

is the corresponding quality control chart. The orange-coloured marker over the word "quality" swings out of sight when the job is running satisfactorily.

U.S. Machine Tool Exports

The following table gives quantities and value of exports of various classes of machine tools from U.S.A. during November, 1951:

	Number	Value $
Engine and tool-room lathes	158	552,982
Light duty bench lathes	106	46,175
Turret lathes	32	993,143
Polishing and buffing lathes	64	37,695
Other lathes	54	811,893
Vertical boring and turning mills	6	117,112
Boring machines	20	383,360
Automatic screw machines	25	426,457
Tapping and threading machines	141	119,005
Milling machines	91	678,664
Gear cutting machines	47	740,095
Drilling machines	173	242,654
Planing and shaping machines	20	228,146
Broaching machines	7	81,056
Honing machines	43	333,756
Surface grinding machines	57	260,736
Tool and cutter grinding machines	64	75,354
Thread grinding machines	--	---
Other grinding machines	82	1,184,174
Sheet and plate metal working machines	..	1,300,141

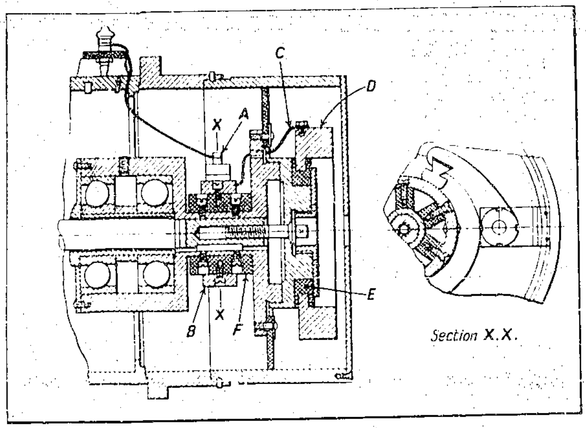

Fig. 3. Sectional View of Disc and Spindle Assembly for the Electric Spark Method of Sharpening Carbide Tools

with satisfactory results on the cemented carbide test pieces. From more than 2,600 tests with material to specification BK 8, the best results were obtained at voltages of from 20 to 25.

The effects of varying the capacitance C, expressed in micro-farads, are shown graphically in Fig. 5 and 6. In Fig. 5, the rate of metal-removal P, expressed in grammes per minute is plotted against amperage, and a series of curves, each corresponding to a different capacitance, is shown. Fig. 6 indicates rates of metal-removal P, (in grammes per minute), plotted against capacitance for electrode-disc velocities of 5 metres per second (980 ft. per minute) and 10 metres per second (1,970 ft. per minute).

The influence of capacity on surface-finish was also studied and some typical test results are shown in Fig. 7. Surface quality is represented by H (height of peaks). (The value of the units is unknown, ED.). These curves are based on tests with a cast-iron disc lubricated with "aviation oil Mark MS." It is believed that for optimum

in Fig. 3. Current is fed through a brush-holder A to a slip ring B, whence it passes, by way of the lead C, to the electrode-disc D. The slip-ring B and the electrode-disc D are insulated from the spindle by Textolite rings E and F. The addition of this extension-spindle represents the major change in the conversion of an orthodox machine for the electric-spark process. Some results of the investigation, concerned with the relationship between the amount of material removed and the current applied, irrespective of circuit-capacity, are shown graphically in Fig. 4. The quantity of material removed, P, is expressed in grammes per minute, and is plotted against amperage I. The voltage employed, in this instance, was 20.

It will be seen from the graph that the highest rate of metal-removal was achieved at an electrode-disc surface speed of 10 metres per second (1,970 ft. per minute). Practical experience, however, indicated an optimum disc-speed of 12 to 15 metres per second (2,360 to 2,950 ft. per minute) while for cutting-tools of softer alloys (other than carbide) and a current of 20 amp., the recommended speed-range is 25 to 30 metres per second (4,920 to 5,900 ft. per minute). These latter figures may be regarded as optima for finishing operations. Further investigations were concerned with the attainment of maximum efficiency of the electrical equipment compatible

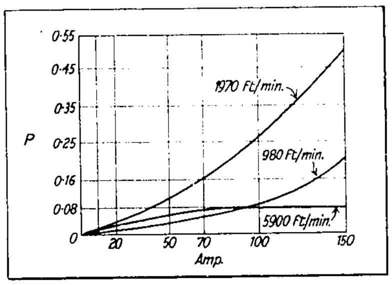

Fig. 4. Curves Showing Metal Removal, P, in Grammes per Minute, from T 15K Cemented Carbide, for Various Current Values (at 20 Volts) and Disc Speeds.

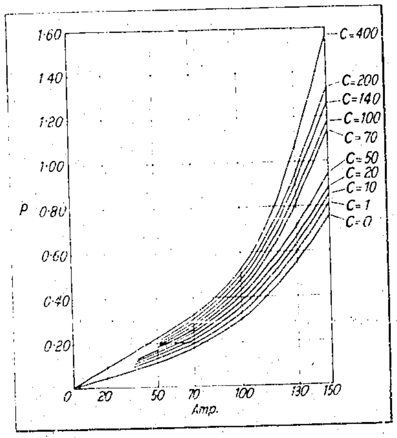

Fig. 5. Curves Showing Metal Removal, P, from BK8 Cemented Carbide, in Grammes per Minute, for Various Values of Current (at 20 Volts) and Capacitance C in Microfarads. The Disc Speed was 1970 ft. min.

surface finishes current values from 3 to 5 amp. should be employed with capacitance from 1 to 5 microfarads, a voltage of 20, and disc speeds of 5,000 to 6,000 ft. per minute.

Metallographic tests of cemented carbide samples treated under recommended conditions did not reveal any sign of micro-cracks. Where porosity was observed, there was little difference between these samples and those ground by conventional methods. The same applies to phase compositions and grain size. With the electric spark method, therefore, under suitable conditions, there is no risk of damaging the material, and this technique could be employed on a commercial scale.

A better indication of the surface finish of cemented carbide tools is afforded by their machining qualities. Tool-life tests were carried out with tools finished by the electric spark method and by conventional abrasive methods. The tools were used for machining various metals, including steel and cast iron, under the following conditions: Roughing, $t \times s = 1.5 \times 0.47$ mm. (0.0591×0.0185 in).: finishing, $t \times s = 1 \times 0.21$ mm. (0.0394×0.0083 in.); fine-finishing $t \times s = 0.5 \times 0.16$ mm. (0.0197×0.0063 in.); where t = depth of cut in mm. and s = feed in mm. rev. Fig. 8 shows curves of cutting speed, in metres per minute, plotted against tool life in minutes, for tools treated (X) by the electric spark method and for those sharpened and finished by abrasives (Y). The life of the former exceeded that of the latter by 5 to 10 per cent. Tests on an industrial scale showed more impressive results. The electric spark method gave 50 per cent greater tool life than abrasive sharpening. Fig. 9 shows the relationship of surface finish to cutting speed for tools treated by both methods.

As cemented carbides are very brittle, excessive pressure against a grinding wheel, especially if it is not running quite true, may cause surfaces cracking. With the electric spark method, however, there is always a clearance between the tool and the disc, and the process is therefore particularly suitable for brittle materials.

The following conditions are recommended when using the electric spark method on an industrial scale:—

Coolant.—Well filtered "aviation oil" or an

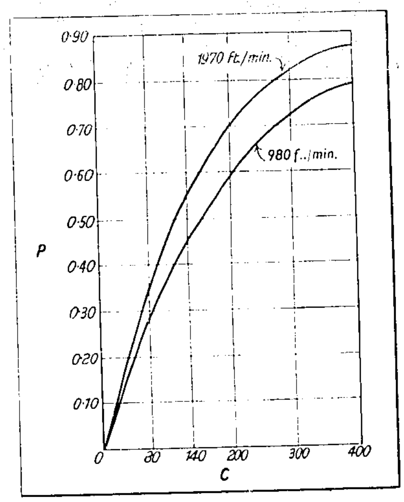

Fig. 6. Curves Showing Metal Removal, P, from BK8 cemented Carbide in Grammes per Minute for Various Capacitance Values, C, in Microfarads, and Disc Speeds of 980 and 1970 ft min. at 220 Volts

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emulsion consisting of "Emulsol" [illegible] with 30-50 per cent water is suitable. Accumulations of swarf or other impurities should be removed from time to time, as required. The flow to the working zone should be fairly copious, but strictly controlled.

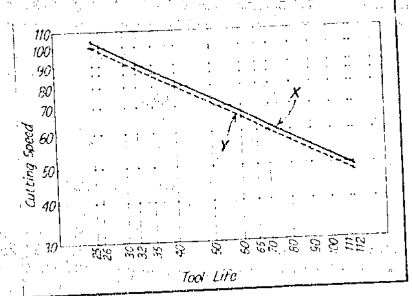
The Electrode Disc is preferably made from aged cast iron, but if profiles are to be formed it may be of steel or copper. The working face should be kept smooth and, for normal forms, the tool should be oscillated relative to the disc during the operation.

The direction of rotation must always be against the cutting edge. To ensure that the disc is under negative D.C. potential, the current collector should be carefully tested for effective contact before work is begun. When the face of the disc is used, the gap should not exceed 0.01 mm. (0.0004 in.), but this may be increased to 0.03 mm. (0.0012 in.) when the periphery of a disc or cylinder is employed. The disc should rotate without perceptible vibration.

The Tool must be in good electrical contact with the positive D.C. supply. All contact surfaces should therefore be kept clean. Top rake angles may be 4-5 deg. larger than when tools are ground with abrasive wheels. Setting time can be reduced by mounting the tool in a universal holder so that one edge after the other can be presented to the disc.

If special machines for the electric spark method are not available, existing machines may be adapted, provided that the above recommendations are observed. Standard electrical switchgear may be used.

The total time required for sharpening a hard metal tool of 20 by 30 mm. section (0.79 by 1.18 in.) by the electric spark method is 6 min. (actual machine time 3.5 min.) whereas con-



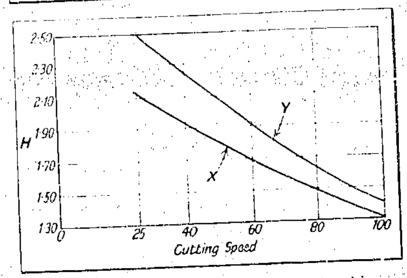


Fig. 8. (Above) Relationship of Cutting Speed in Metres per Minute and Tool Life in Minutes, for Tools Sharpened (*X*) by the Electric Spark Method, and (*Y*) by Abrasive Wheel

Fig. 9. (Below) Relationship of Surface Finish of Work, (*H* = Maximum Height of Ridges) and Cutting Speed in Metres per Minute for Tools Sharpened (*X*) by the Electric Spark Method, and (*Y*) by Abrasive Wheel

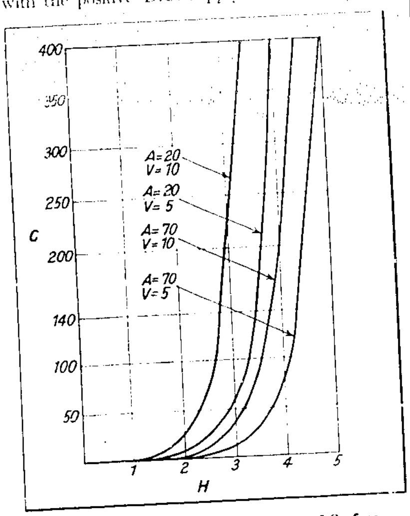


Fig. 7. Curves Showing Relationship of Surface Finish, *H* (Maximum Height of Ridges) and Capacitance C for Various Values of Current, *A*, and Voltage *V*

ventional grinding would require 4.5 to 5 min. For roughing operations on the various faces of the tool the ranges of voltage, current and capacitance employed are 20 to 30V, 120 to 250A., and 300 to 500 microfarads. For finishing the ranges are 15 to 20V, 3 to 7A., and 1 to 20 microfarads. Roughing speeds range from 2,400 to 2,800 ft. per minute, and finishing speeds from 5,000 to 6,000 ft. per minute. The cost of the abrasive method is estimated to be 70 to 100 per cent greater than that of the electric spark method. It is believed that the new technique may offer particular advantage for sharpening form-tools, chasers, thread-cutting tools, milling cutters, and gear cutters, also that it may be possible to obtain very high finishes on tool surfaces.

† See British Patent, 637,793, Sept. 24, 1946, and the following publications: B. R. and N. I. Lazarenko, "The Physics of the Electric Spark Methods of Machining Metals," Ministry of Electrical Industry, U.S.S.R., Moscow, 1946; Stanki i Instr., Vol. 17, 1946, pp 8-11 (Dec.); Vol. 18, 1947, pp. 4-8 (Feb.); and Vestnik Machinostroinya, Vol. 27, 1947, pp. 25-36 (Jan.).

Cam Economy

By J. McDONALD

It is the experience of the writer that many firms which use single-spindle automatic screw machines waste a great deal of time and effort by failing to employ, wherever possible, cams already in their tool stores for the production of components that are similar to those for which the cams were originally designed. It will be appreciated that "similar" refers expressly to components requiring cams of approximately the same throw, and not to the actual form of the component.

If cams are to be selected for the production of components for which they were not specifically designed, it is essential that a careful and systematic record should be kept of all those that are already in existence.

TABLE 1. METHOD OF TABULATING CROSS SLIDE CAMS

Type: 4¼ in. dia. Cross-slide Cams (One Lobe)
Basic Dimensions: 4¼ in. diameter by 1 in. bore
Range 0.100 0.149 incl.

Cam number	Rise on lobe	Hundredths	Cam number	Rise on lobe	Hundredths	Cam number	Rise on lobe	Hundredths
	0.100	21		0.111	25		0.120	18
	0.109	6		0.115	18		0.125	14
	0.108	14		0.119	32		0.121	32

This, unfortunately, is seldom done, although the advantages are apparent. The following method of compiling such records is therefore suggested.

Cams used on the front, back and third slides are considered first, because the majority of cross slide cams have only one uniformly-generated lobe and they can be recorded in a single table. They are all interchangeable, except, of course, where the bores of the various cross slide cams differ. For example, the third slide cam on a No. 68 B.S.A. machine cannot be used to operate the front or back slide because of the difference in bore diameters.

There are only two constants for any cam, apart from its basic dimensions, namely:—(1) The rise in inches of the cam lobe. (2) The number of hundredths of cam surface occupied by the lobe. The table compiled must therefore indicate these two factors, and a suggested layout record for cross slide cams is shown in Table 1.

Since lead cams may have a number of lobes, it may be felt that it is scarcely worth while to record them. Such records can, however, be usefully employed, and an effective method of tabulation is shown in Table 2.

It is, of course, undesirable that uneconomical time cycles should be permitted merely in order to take advantage of existing cams. It is suggested, therefore, that the cam designer should prepare the usual cam layout for each job, but, before drawing the cams, should refer to the prepared lists to ensure that cams are not designed and ordered which are almost duplicates of those in stock, unless, of course, practical requirements justify duplication.

TABLE 2. METHOD OF TABULATING LEAD CAMS

Type: 7 in. dia. Lead Cams with 4 Lobes
Basic Dimensions: 7 in. dia. by 1¼ in. bore

Cam number	1st Lobe		Index (per cent)	2nd Lobe		Index (per cent)	3rd Lobe		Index (per cent)	4th Lobe	
	Rise on cam	No. of Hundredths		Rise on cam	No. of Hundredths		Rise on cam	No. of hundredths		Rise on cam	No. of hundredths
	0.140	9	4	0.545	16	5	0.500	18	5	0.230	6
	0.125	14	3	0.625	27	4	0.040	3	4	0.505	10
	0.040	5	3	0.210	19	3	0.180	11	3	0.055	9